



# Manufacturing with RDRAM\* Memory Technology Part I

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Last Updated: Jan. 5, 2000

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# Agenda - Part I

- Introduction
- RDRAM Technology Overview
  - Description of RDRAM Solution
  - Intel® 820 Chipset Architecture Configurations
  - Intel® 840 Chipset Architecture Configurations
- Vendor Solutions
  - Mother Board Integration
  - System Integration

# Manufacturing with RDRAM Memory Technology

- Introduction

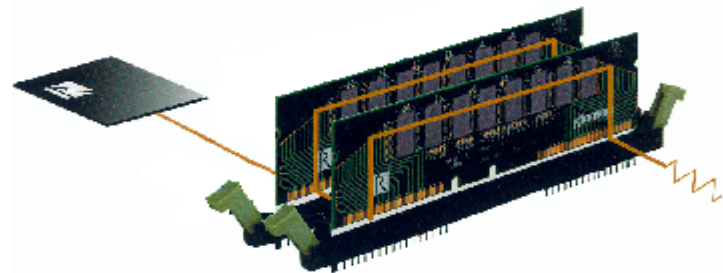
- The intent of this training is to discuss RDRAM Information as related to manufacturing and associated solutions.
  - » Educate Customers on RDRAM technology Solutions for faster manufacturing ramp.
  - » Sharing information and manufacturing Best Known Methods that may reduce manufacturing induced failures and No Defect Found.
- Board design, application information, or detailed thermal information are not being addressed in this presentation.
  - » Additional detailed documents are available from your Field Sales Representative. Also refer to the URLs and Reference Documents in this material.
- Although, the Intel® Chipsets will be addressed, this Manufacturing Advantage material is focused on RDRAM specific portion only.

# Manufacturing with the RDRAM Memory Technology

- Direct RDRAM Technology Overview
  - Description of RDRAM Device Solution
  - Intel® 820 Chipset Architecture Configurations
  - Intel® 840 Chipset Architecture Configurations

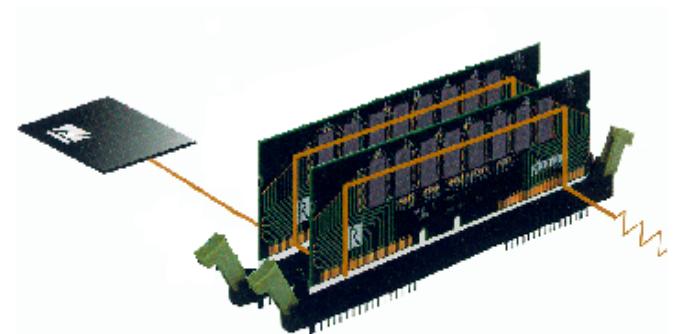
# Direct RDRAM Overview

- Direct RDRAM is a new memory architecture that allows for very high speed data transfer on the Rambus\* Channel.
  - The Rambus Channel is a narrow high-speed bus.
- A single Rambus\* DRAM delivers 1.6 GB/s (1.5 GB/s effective) over the Rambus Channel
- RDRAM delivers up to 3x the *effective* bandwidth of PC100 SDRAM



# Direct RDRAM Overview

- Features Include:
  - » > 95% channel utilization with transaction pipelining.
  - » 1 - 32 RDRAM devices per channel
  - » 64Mb, 128 Mb, or 256 Mb RDRAM Technology
    - ▣ 256 MB, 512MB, 1 GB max memory array size per channel.
  - » Active RDRAM Device Power Management
    - ▣ Nap & Power down modes
  - » Configurable ECC Operation
    - ▣ Single bit ECC and scrubbing
    - ▣ Double bit error detection
- RDRAM Device Benefits include:
  - » Constant Computing
  - » More realistic environments
  - » Platform longevity and stability
  - » Faster processors, graphics and I/O



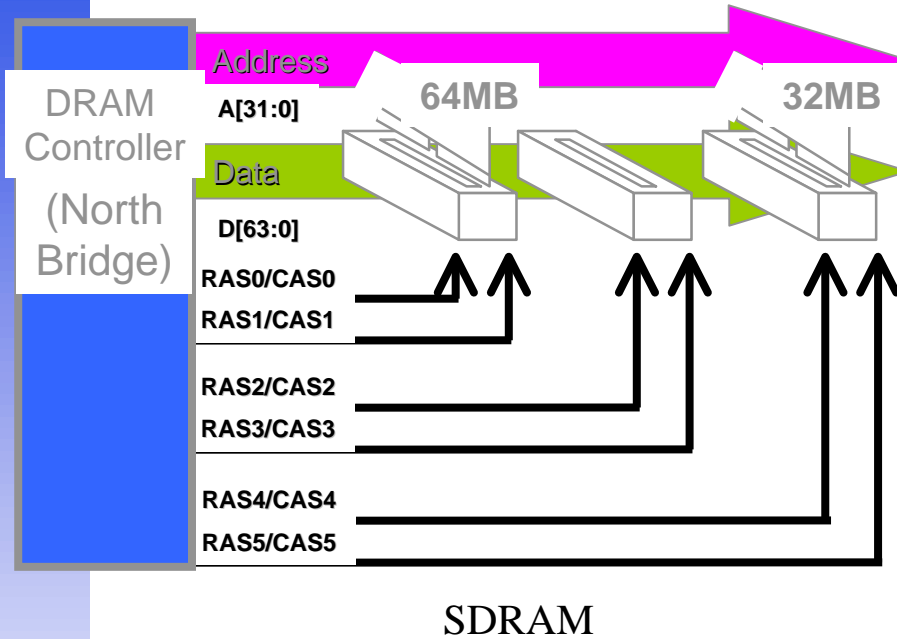
# Direct RDRAM Overview

- Terminology and Definitions:
  - RIMM\* Module - A RIMM module is a memory module for use in PCs, workstations, and servers. The Rambus RIMM module is a general purpose, high-performance memory subsystem consisting of up to sixteen Rambus DRAM (RDRAM\*) devices.
  - RDRAM - Direct RDRAM or RDRAM Technology
  - DRCG - Direct Rambus\* Clock Generator
  - CRIMM - Continuity RIMM or Continuity Module
  - RSL - Rambus\* Signal Level
    - » Refers to the Rambus\* high speed signals and voltage levels.
  - Channel - High speed physical interface for RSL signals including MCH Packages, motherboard, connectors, RIMM, and CRIMM.
  - SPD - Serial Presence Detect.
    - » This is an EEPROM on the RIMM Modules containing all RIMMmodule Information.
  - PC600, 700, 800 - Refers to speed grade of memory.
  - RAC - Rambus\* ASIC Cell
  - RMC - Rambus Memory Controller (e.g. MCH)

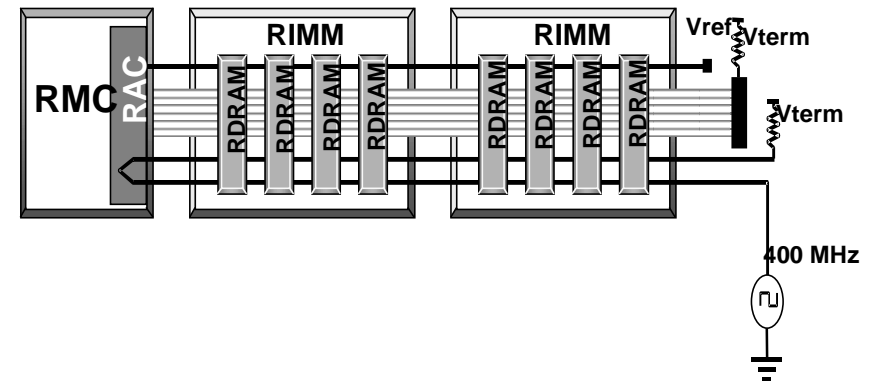


# Direct RDRAM Overview

- Terminology and Definitions - Continued:
  - MCH - Memory Controller Hub ( part of Intel® 820 and Intel® 840 Chipsets)
    - » Also referred to as RAC and RMC.
  - MTH - Memory Translator Hub
    - » This is part of the Intel® 820 Chipset and converts RDRAM device signal to SDRAM.
  - MRH -R - Memory Repeater Hub - RDRAM device
    - » This is part of the 840 Chipset and provides additional RDRAM interface
  - MRH -S - Memory Repeater Hub - SDRAM
    - » This is part of the Intel® 840 Chipset and provides SDRAM interface
  - MEC - Memory Extension Card - Potential with Intel® 840 Chipset solution.
  - MECC - Memory Extension Card Connector - Reference to the connector utilized for the MEC solution.



- Parallel Architecture (64 bit)
- Physical grouping of memory devices by RAS and CAS lines
- During a memory access specific RAS and CAS lines are enabled
- Slots can be left unpopulated.

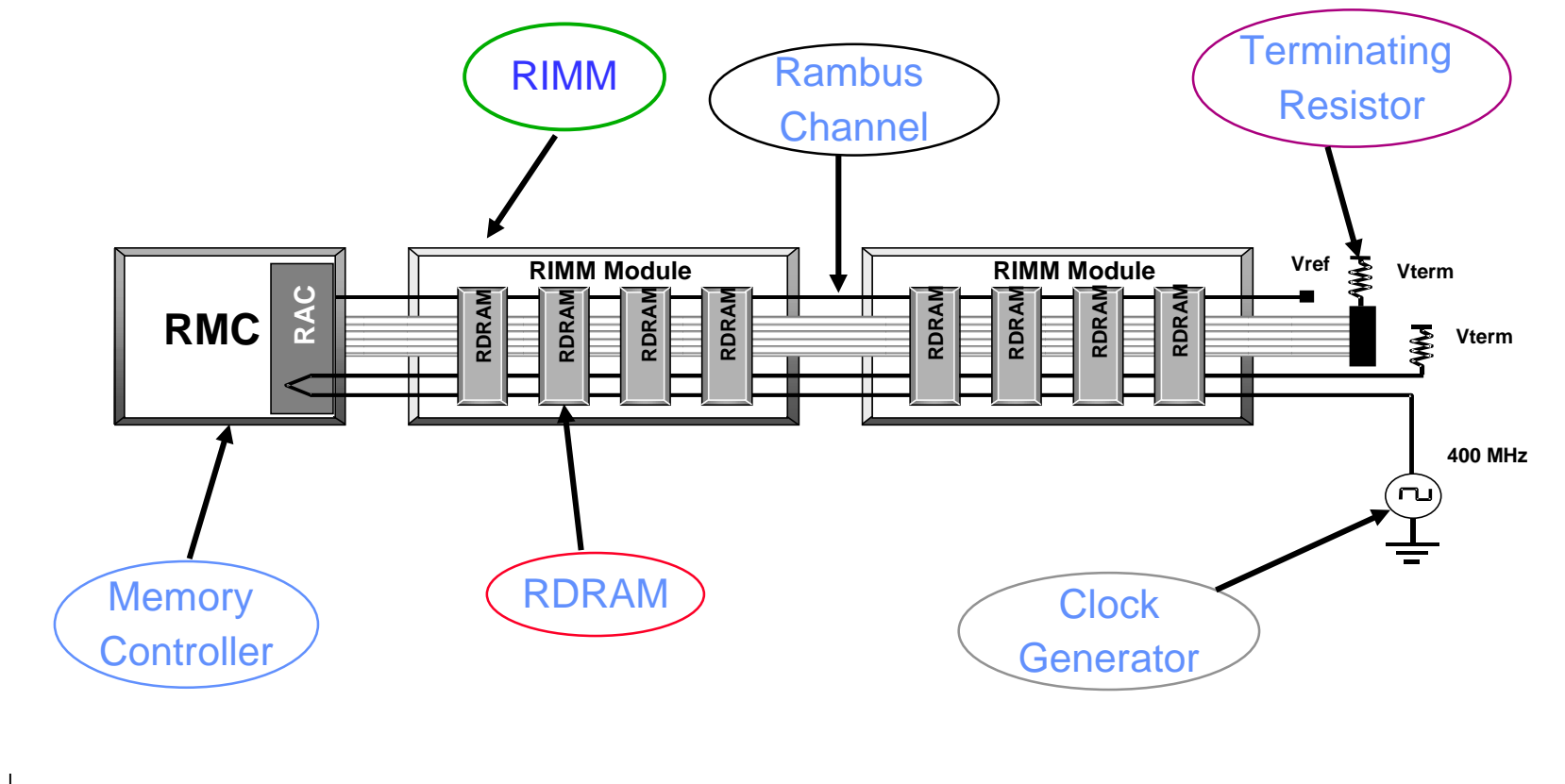


## RDRAM

- Logical groupings of devices based on technology type.
- A RIMM module can have any number of devices on board
- Continuous Rambus memory channels, slots cannot be left unpopulated.
- Devices chained together serially unlike SDRAM (16 bit)

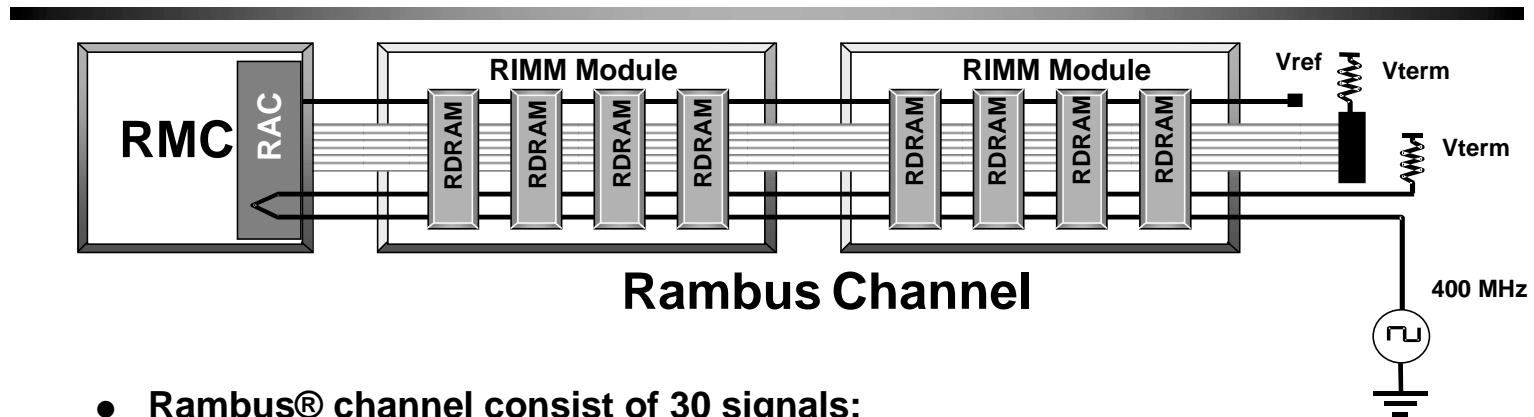
# Direct RDRAM Overview

## Rambus Channel Electrical Architecture



# Direct RDRAM Overview

## Rambus® Channel Electrical Architecture



- Rambus® channel consist of 30 signals:
  - CLOCK: Clock to Master(CTM) pair, Clock from Master (CFM) pair
  - 16/18-bit data interface
  - 8-bit control interface
- Uniform transmission line with 28 OHM +/- 10% channel impedance
- Single-ended termination in Vterm = 1.8V, 28 OHM impedance match
- Reference voltage Vref = 1.4V
- Rambus Signaling Level (RSL) = 1.8V to 1.0V signal swing

# Intel® 820 Chipset Platform

## AGP Bus

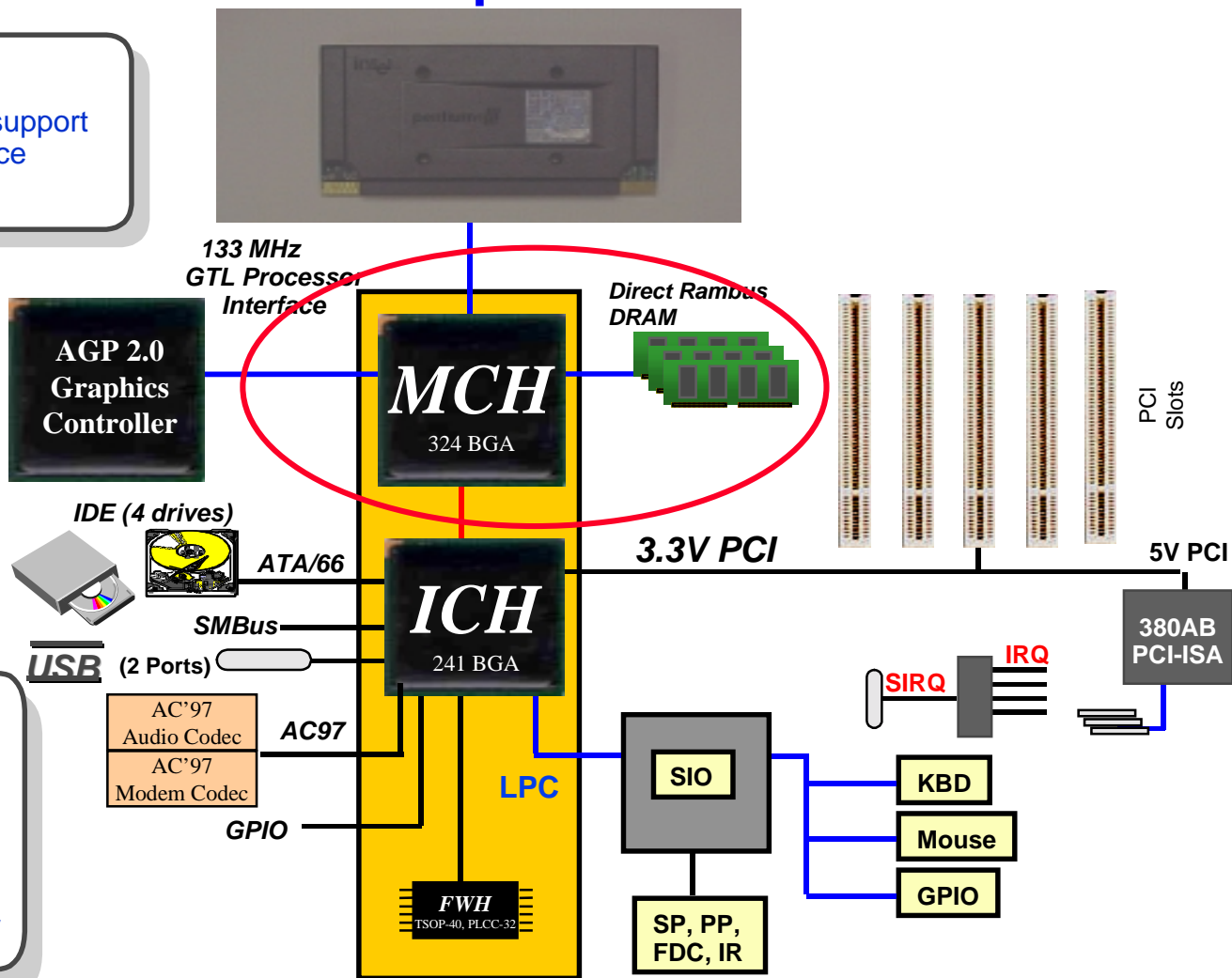
- High performance graphics support
- 66Mhz/133Mhz AGP Interface
- Single device load

## PCI Bus

- 5v tolerant
- PCI 2.2 Compliant
- **6 PCI masters**

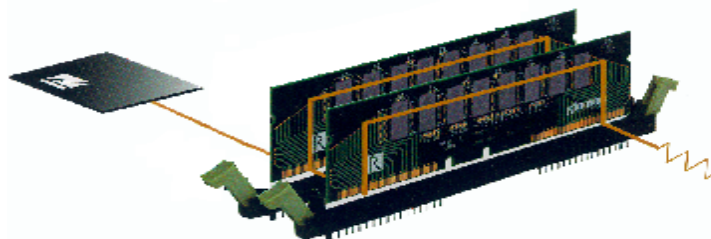
## 820 Features

- HUB Architecture
- Optimum Concurrency
- Isochronous Transfers
- Enhanced Manageability / Security



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# Intel® 820 Chipset Solutions



## Intel® 820 Chipset - RDRAM Configurations

- RIMM Down Solution via the MCH - (Memory Controller Hub)
- 0 + 2 Solution (0 RIMM + 2 DIMM)
  - MCH to MTH - Memory Translator Hub to SDRAM Memory

\* Note - 133 FSB runs at 266 Memory speed.

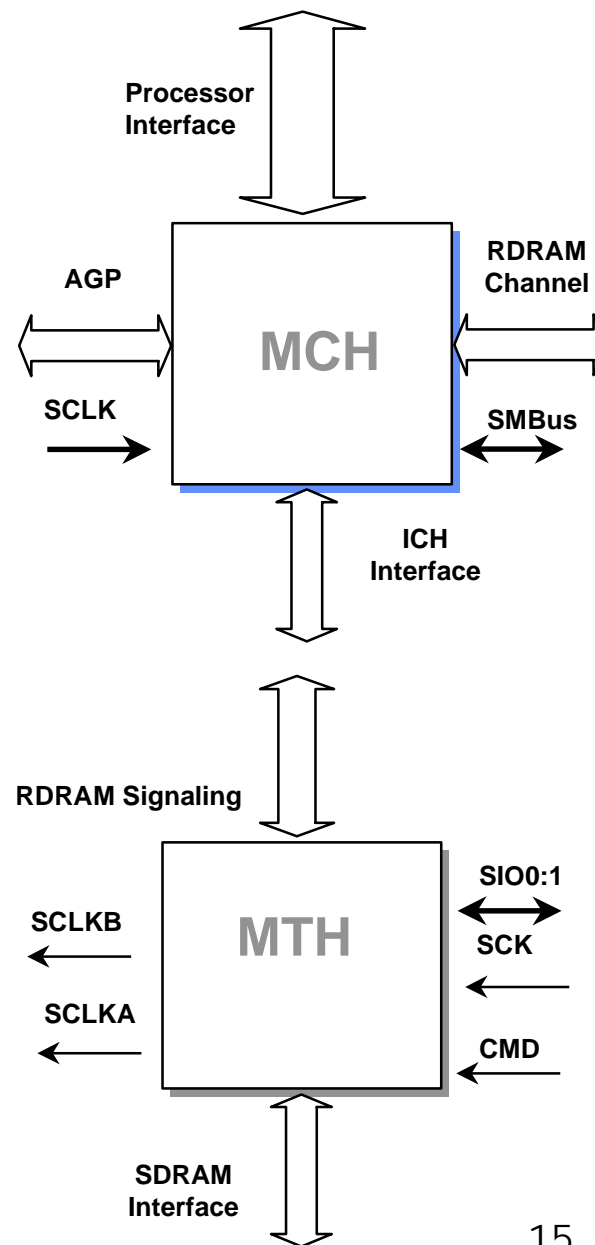
# Intel® 820 Functional Overview

- **Memory Controller Hub for RDRAM (MCH)**

- Supports Pentium (R) II processor and Pentium (R) III processor at 100/133 MHz.
- Supports one or two processor configurations.
- Supports up to 1GB with 1 RDRAM™ channel (256 Mb technology)
- Supports PC600, PC700, PC800 Direct Rambus DRAM Modules.
- Supports up to 32 RDRAM devices on the RAMBUS Channel.

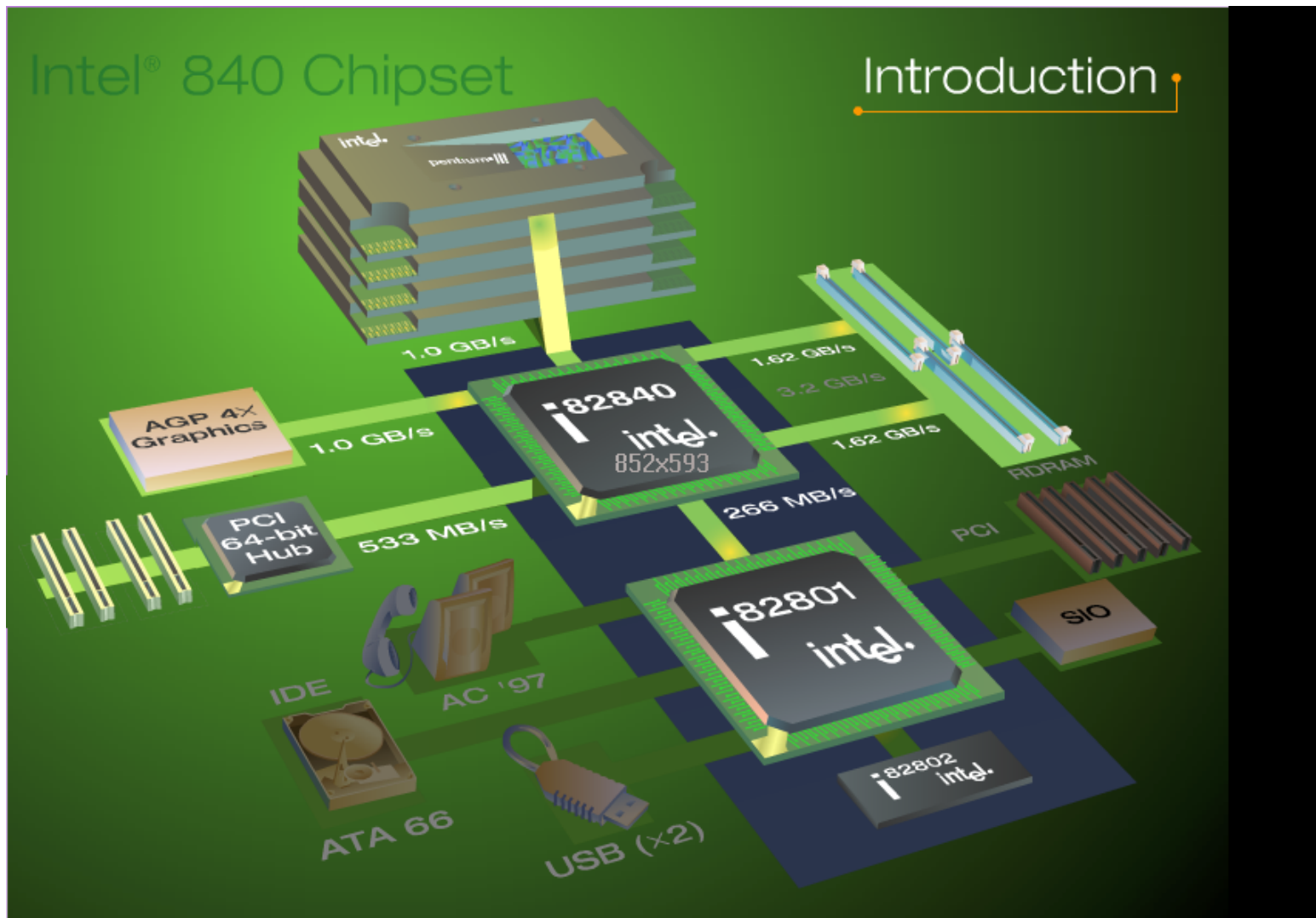
- **Memory Translator Hub for SDRAM conversion (MTH)**

- Converts RDRAM Signals to SDRAM including support for 100 MHz SDRAM
- Supports up to 4 SDRAM rows
- Clock Generation for SDRAMs.
- Power Management Features supported
- Complies “2 Cycle” command timing rules
- Supports Current Calibration, Temperature Calibration and Levelization



## Intel® 840 Chipset Functional Overview

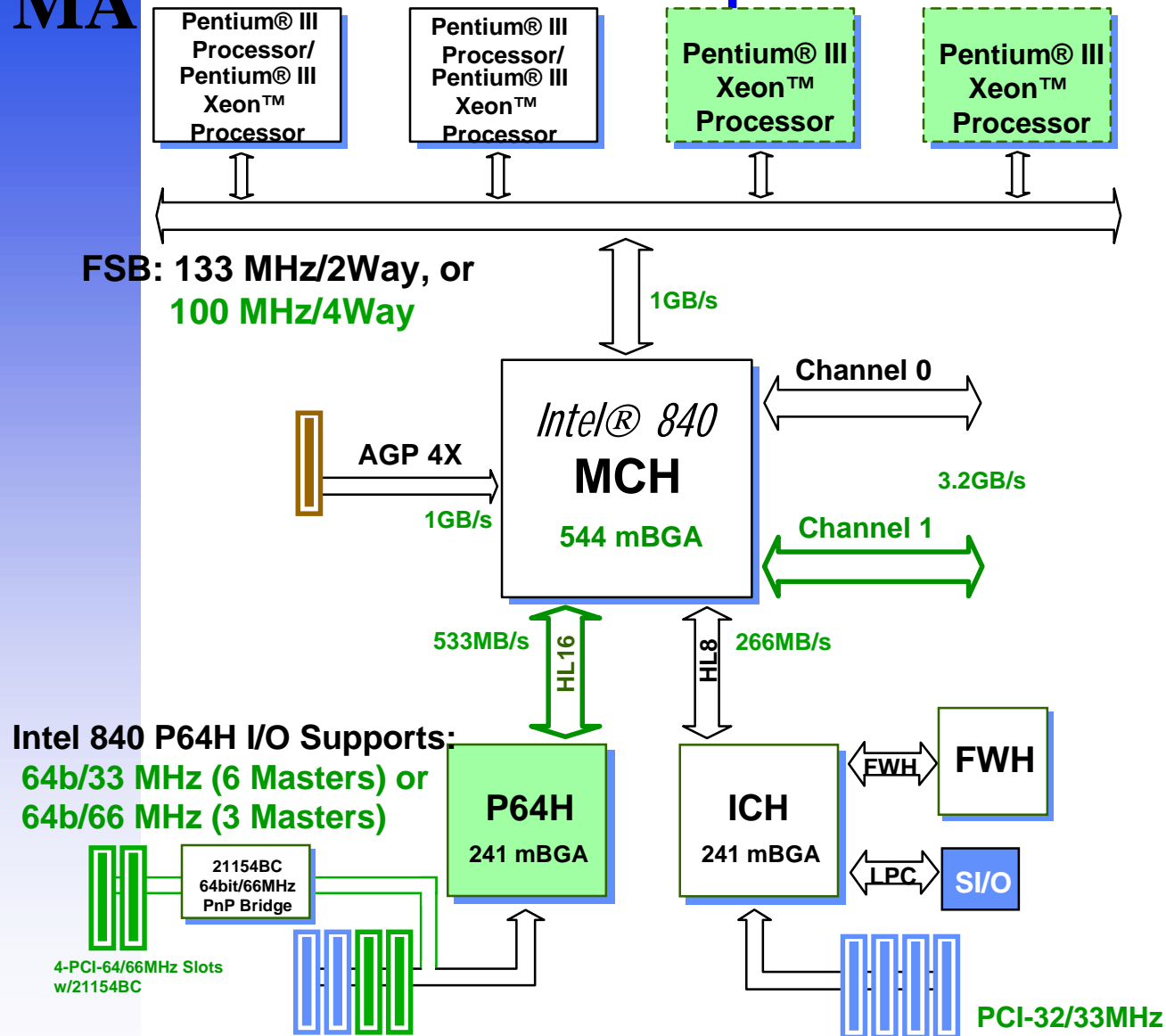
## Intel® 840 Chipset Block Diagram



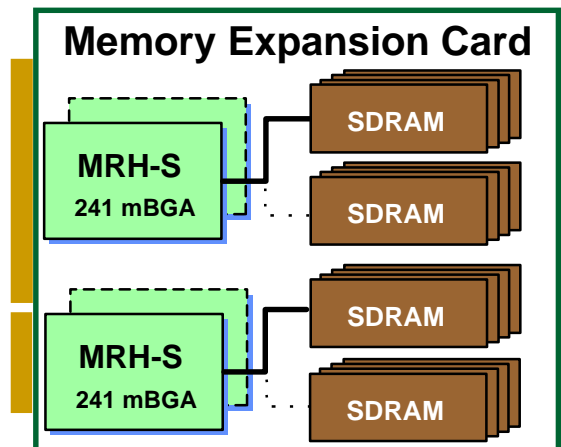
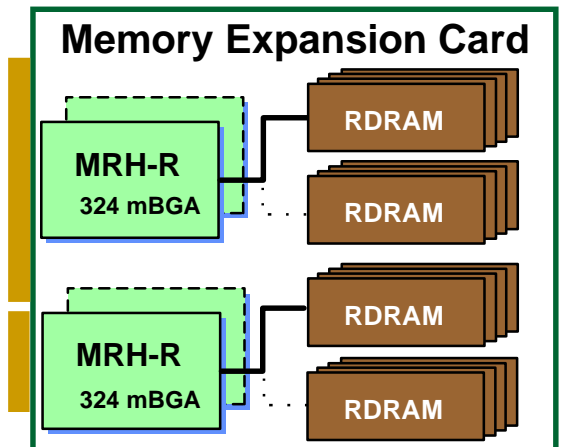


MA

# Intel® 840 Chipset Block Diagram



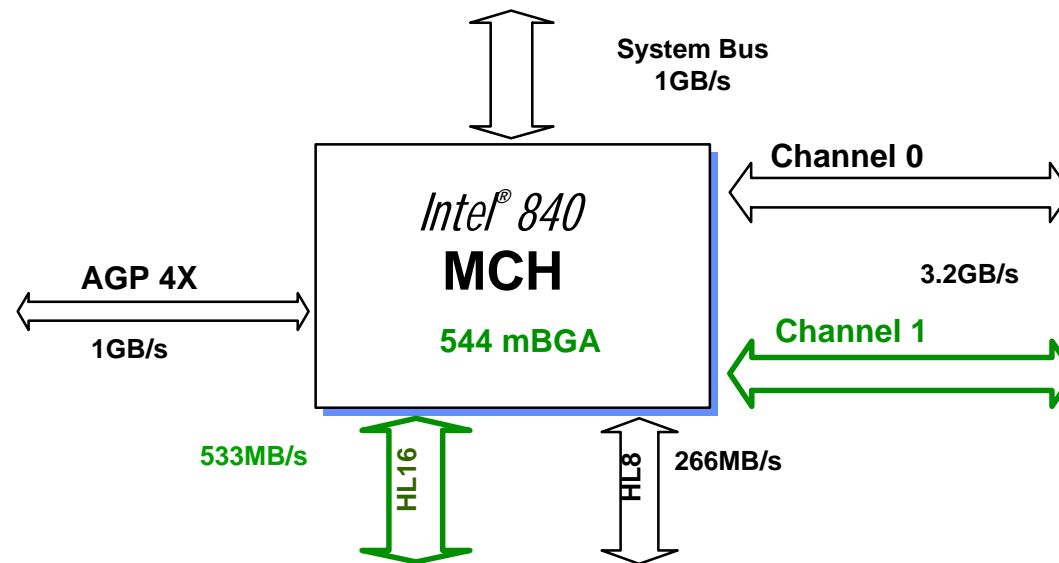
Up to 8GB of RDRAM or SDRAM.



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# Intel® 840 Chipset Memory Controller Hub



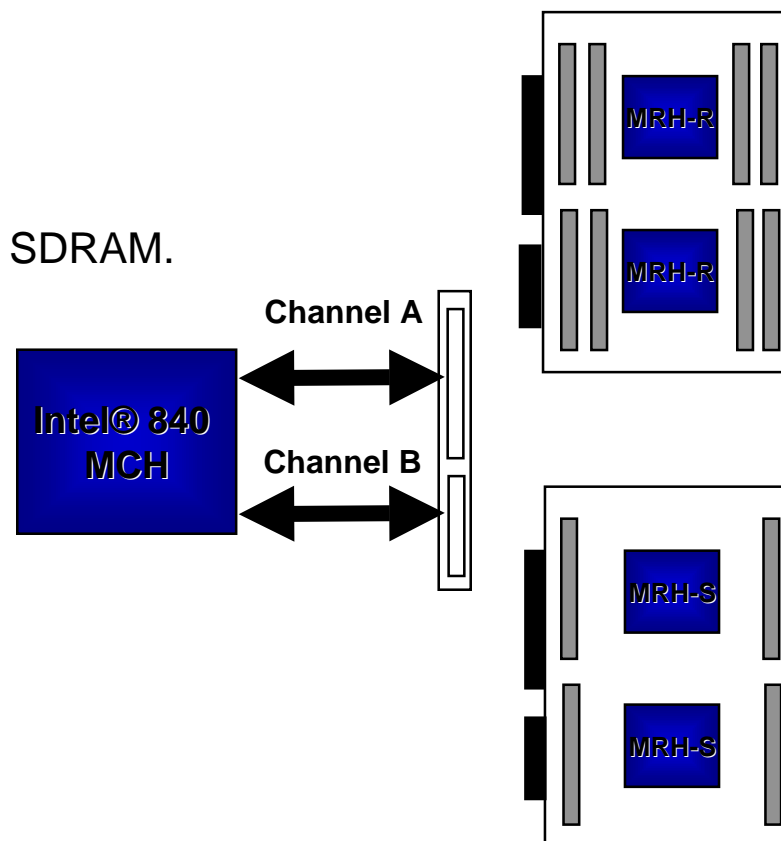
- **Dual Direct RDRAM Channels**

- 2 channel operating in lock-step at 300MHz or 400MHz.
- Supports 2 RIMMs or MRH-R / MRH-S per channel
- Support 64 RDRAMs and up to 2 GB using 64 Mb, 4 GB using 128 Mb, 8 GB using 256 Mb
- Up 3.2G/s memory bandwidth
- ECC Support with HW single bit scrubbing

# Intel® 840 Chipset Functional Overview

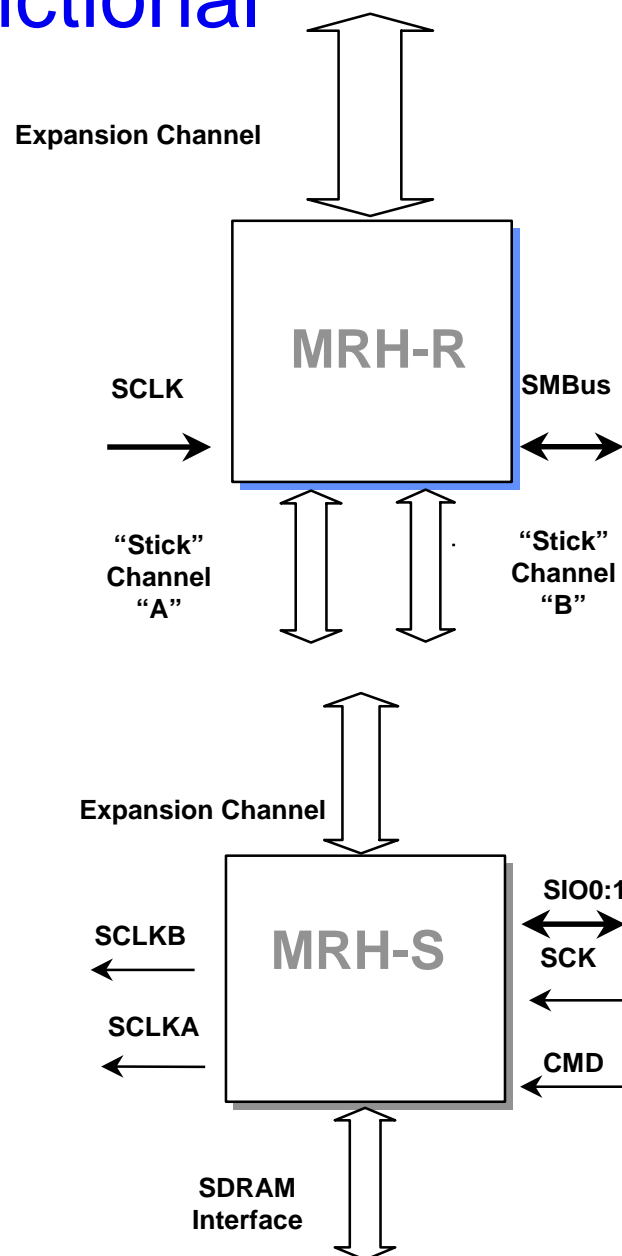
## Memory Controller Hub & Repeater Hubs

- Supports PC600 & PC800 RDRAM
- Supports PC100 (SDRAM) with MRH-S
- Two Direct RDRAM™ Channels
- Supports up to 8GB of either RDRAM™ or SDRAM.
- MRH-R
  - Converts 1 RDRAM™ Channel to 2
  - Doubles RDRAM™ Capacity
  - Integrated SMBus Controller
- MRH-S
  - Converts RDRAM™ Channel to SDRAM
  - Memory Interleaving w/multiple MRH-S
- Memory Expansion Card Connector
  - Same motherboard connector supports RDRAM and SDRAM



# Intel® 840 Chipset Functional Overview

- **Memory Repeater Hub for RDRAM (MRH-R)**
  - Supports up to 2GB with 2 RDRAM™ channels
  - Includes logic for Nap Entry/Exit, Power-down Exit, Refresh and Pre-charge on channels
  - Provide control for 2 external DRCG clock generators
  - Integrates System Management Bus (SMB) controller to access the RIMM SPD EEPROMs
- **Memory Repeater Hub for SDRAM (MRH-S)**
  - Supports up to 4 SDRAM rows
  - Operates in interleaved mode with 2 MRH-S on each expansion channel
  - Complies “2 Cycle” command timing rules
  - Supports Current Calibration, Temperature Calibration and Levelization



# Reference Information

- Rambus® Technology Information
  - [http://www.rambus.com/general/technology\\_overview.html](http://www.rambus.com/general/technology_overview.html)
  - <http://www.rambus.com/developer/downloads/TechOV.pdf>
  - <http://developer.intel.com/design/chipsets/memory/rdrdram/index.htm>
- Intel® Chipset Information
  - <http://developer.intel.com/design/chipsets/datashts/>
- Training Classes
  - <http://www.mindshare.com/>

# Manufacturing with RDRAM Memory Technology

- Vendor Solutions
  - Motherboard Integration
  - System Integration

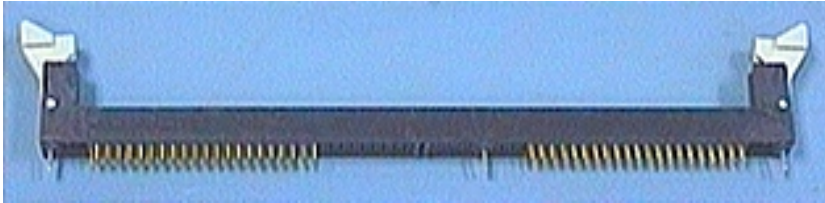
# Vendor Solutions

- Vendor information, contacts, and potential solutions.
  - » RIMM Module
  - » Continuity RIMM Module
  - » RDRAMClock Generators (DRCG)
  - » Heatsinks
- Customer will need to qualify these vendor solutions in their application.
- Customer will need to qualify the thermal solutions in their applications.
- Customer will need to evaluate and fine tune the surface mount process for their board application.

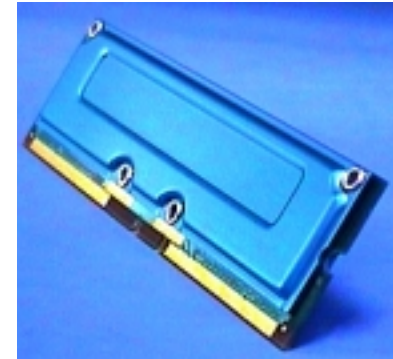
NOTE: Each hardware vendor is responsible for providing their respective product data. Intel does not supply vendor test results, product specifications, price projections, or schedules. The hardware vendor remains solely responsible for the design, sale and functionality of its product, including any liability arising from product infringement or product warranty and Intel assumes no liability for vendor products, either alone or in combination with other Intel products.

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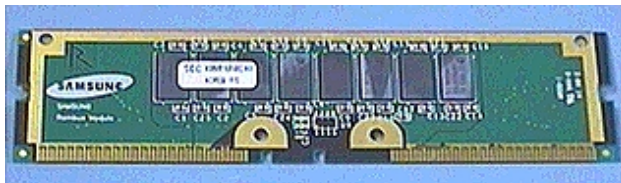
# Ingredient Physicals



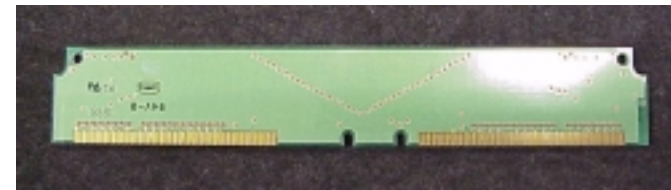
RIMM Connector



Heat Spreader



RIMM Modules



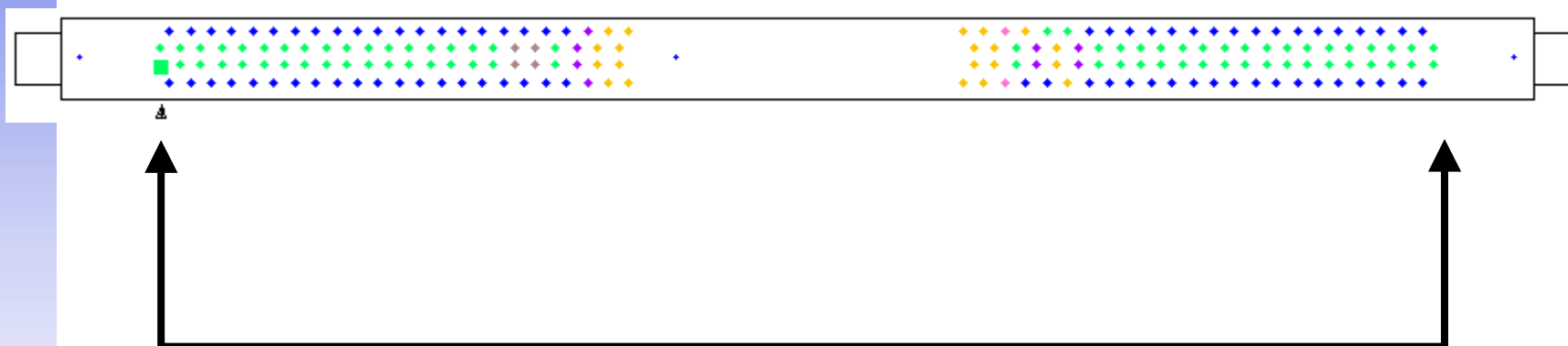
Continuity RIMM  
Module



DRCG (Clock Chip)



## RIMM Connector:

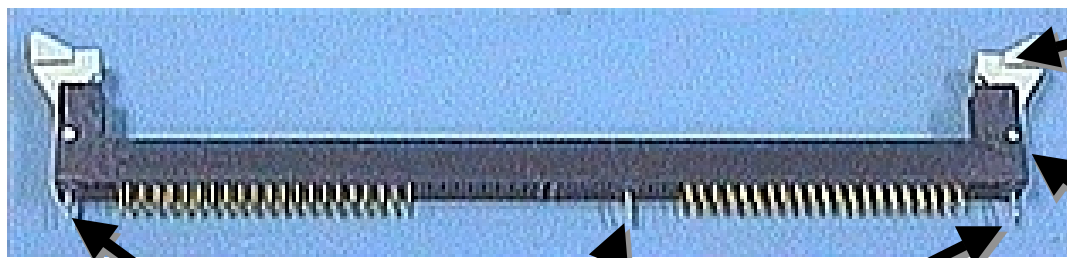


**184 Pins RIMM**

## Supports RIMM Modules

# RIMM Connector:

## Design Features



**Positive Lock Latches**

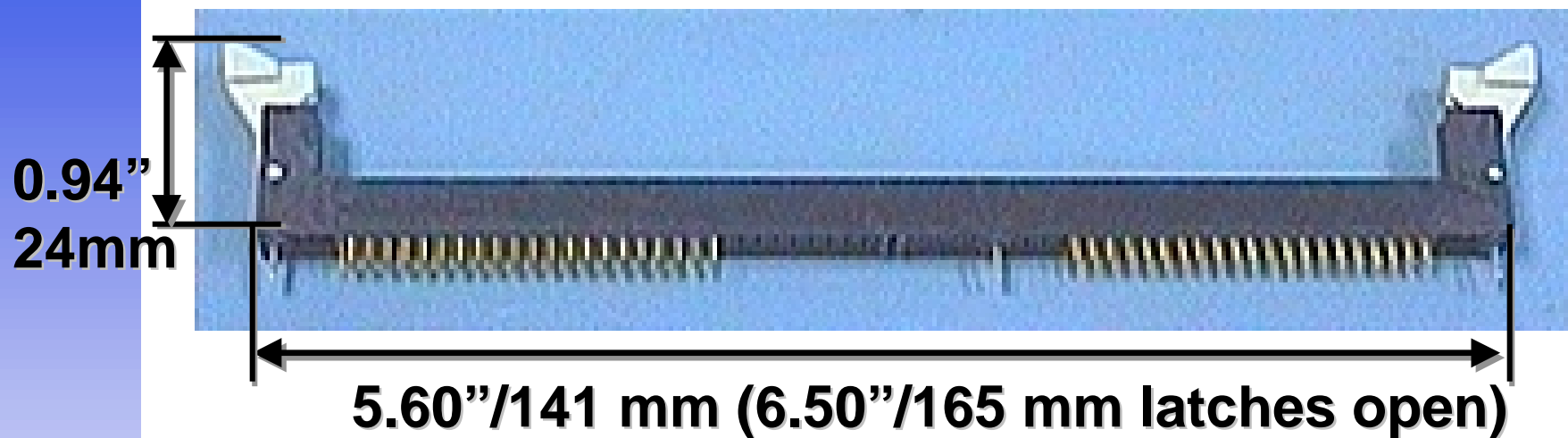
**Raised Latch Pivot Point**

**Enhanced PCB Anchor Stakes**

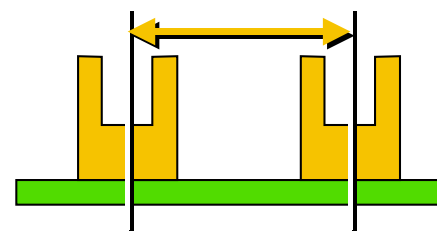
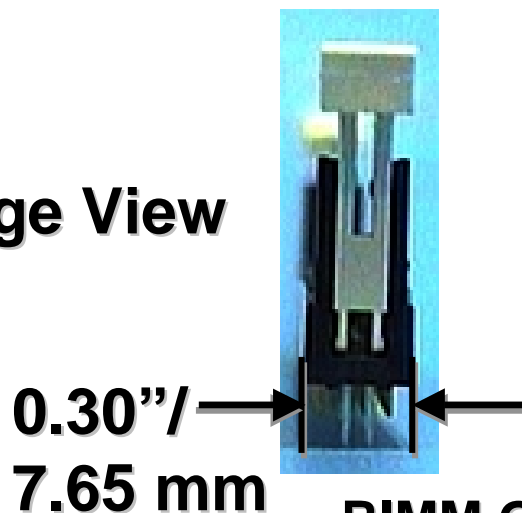
MA

# RIMM Connector:

## Dimensions



Edge View



**Connector Spacing**

**Min = 0.4"/10 mm (mfg.)**

**Nom = 0.45"/11.5 mm (n.c.)**

**RIMM O.D. / Spacing same as DIMM**



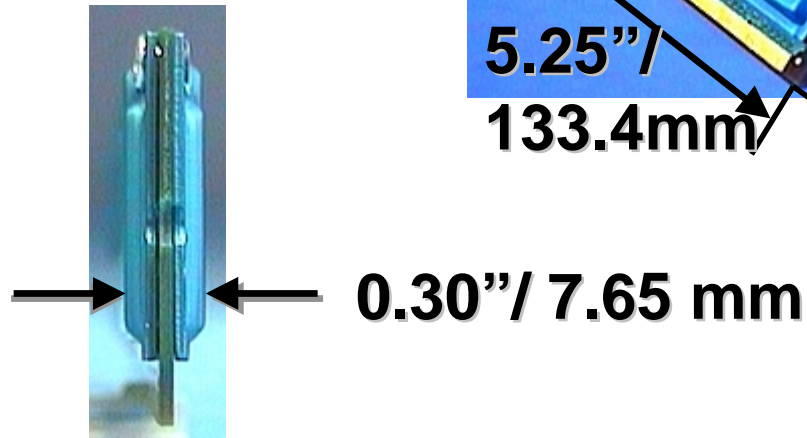
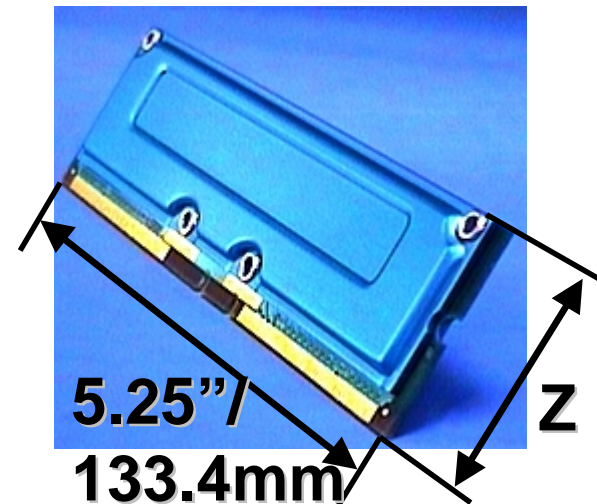
Last Updated: Jan. 5, 2000

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# RIMM Module:

## Dimensions

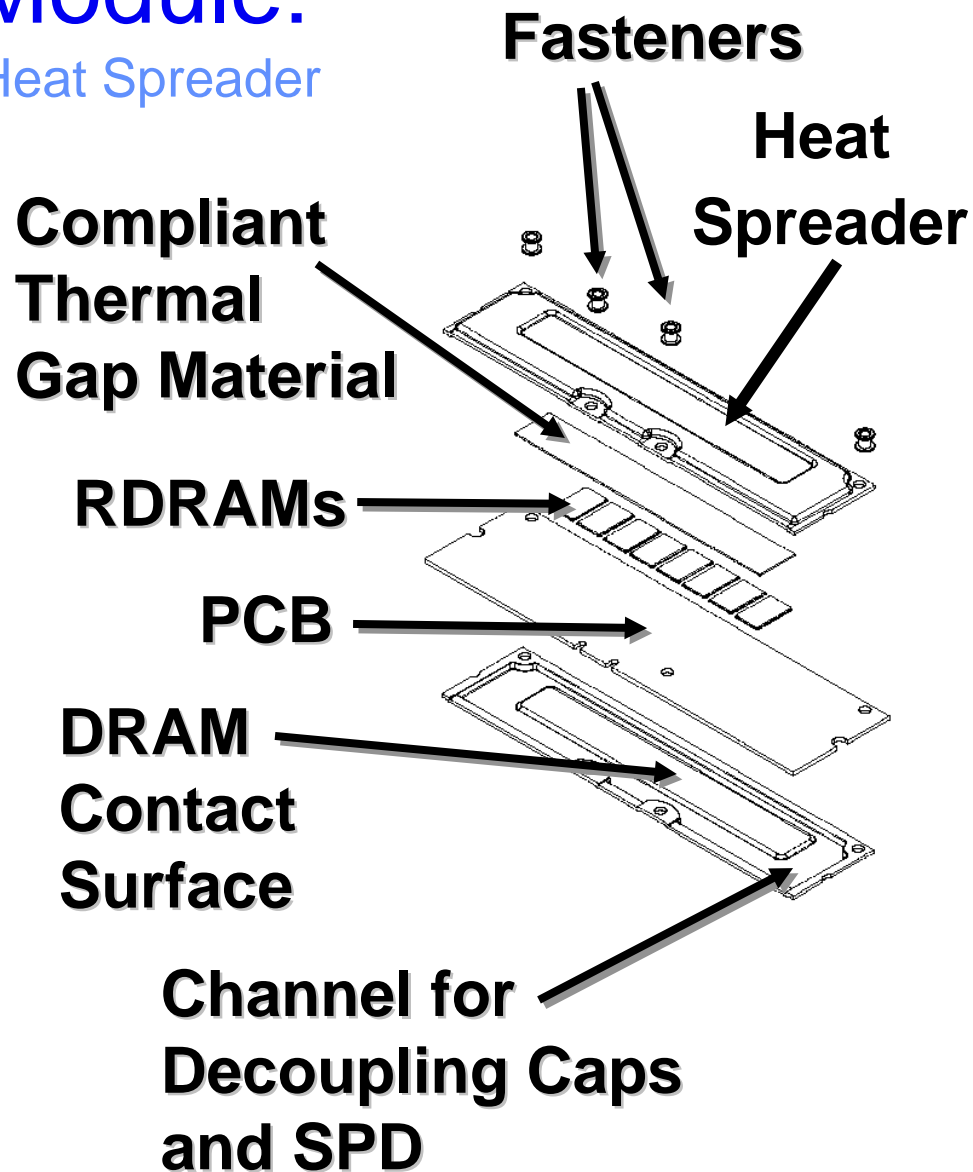
- Production: Z = 1.25"/31.75 mm
- Dimensions w/ Heat Spreader



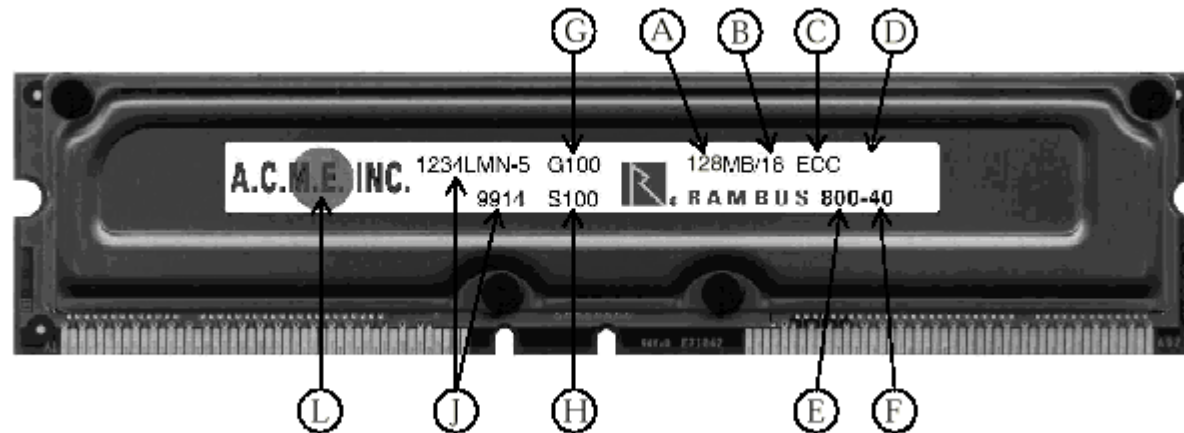
**2-RIMMs same volume as 2-DIMM's**

# RIMM Module:

Assembly w/Heat Spreader



# RIMM Module Marking Information



A. Module Memory Capacity

B. Number of RDRAMs

C. ECC Support

D. Reserved (future use)

E. Memory Speed

F. tRAC - Row Access Time

G. Gerber Version

H. SPD Version

J. Vendor Part No, date code, etc..

K. Vendor barcode (optional/not shown)

L. Vendor Logo

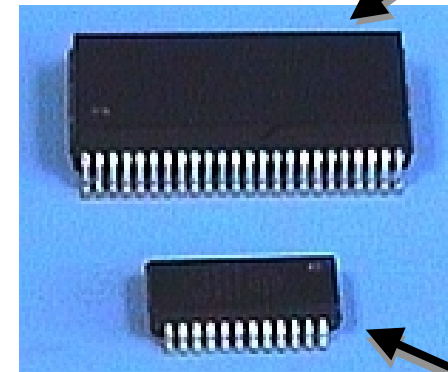
Reference Rambus RIMM Module Data sheet @

[http://www.Rambus.com/developer/support\\_rimm.html](http://www.Rambus.com/developer/support_rimm.html)

# DRCG:

Direct Rambus Clock Generator

**CKBUFF - 440BX**  
(48 pin SSOP)

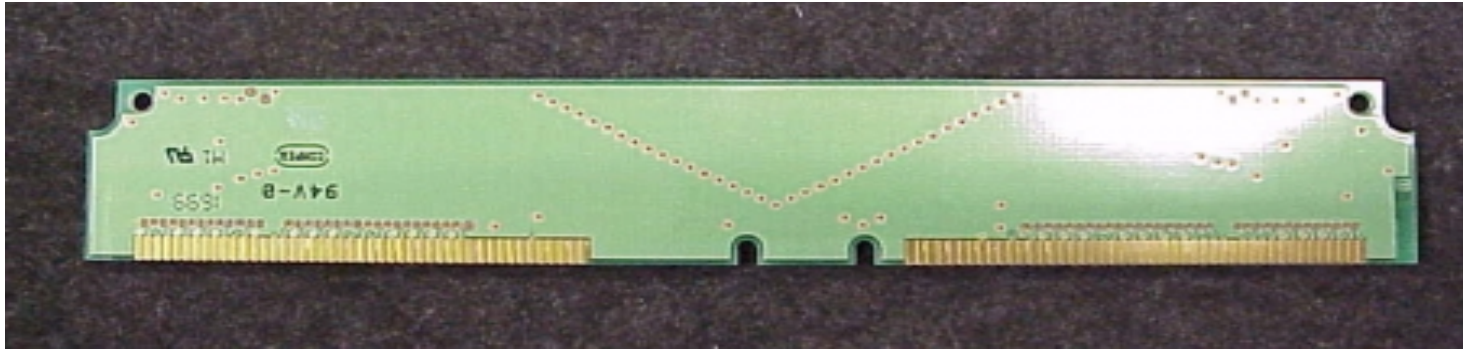


**DRCG**  
(24 pin QSOP)

- EMI - Support
  - Supports Spread Spectrum Clocking for EMI Suppression.
- Functional at 267 - 400MHz
  - Generates RDRAM device/Differential Clock pair.
  - Based on CPU/2 clock

**Reduced pin count & board space**  
**EMI suppression designed in**

# Continuity RIMM Module



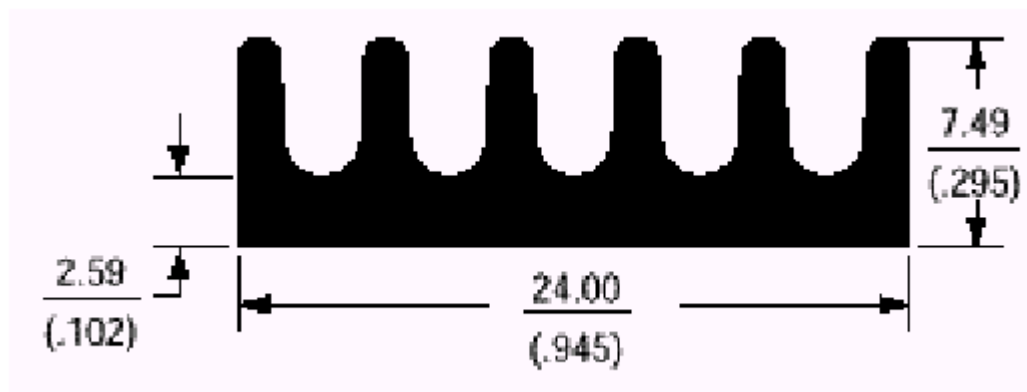
## Features:

- 184 edge connector pads with 1mm pad spacing
- Used with 800, 711 and 600 MHz Rambus memory subsystems
- Maximum RIMM continuity module PCB size: 133.5mm x 21.8mm x 1.37mm (5.25" x 0.86" x 0.054")
- Gold plated edge connector pad contacts
- No active or passive components
- Suitable for use with 184 or 168 contact RIMM Connectors
- 28 $\Omega$  Typical Module Impedance

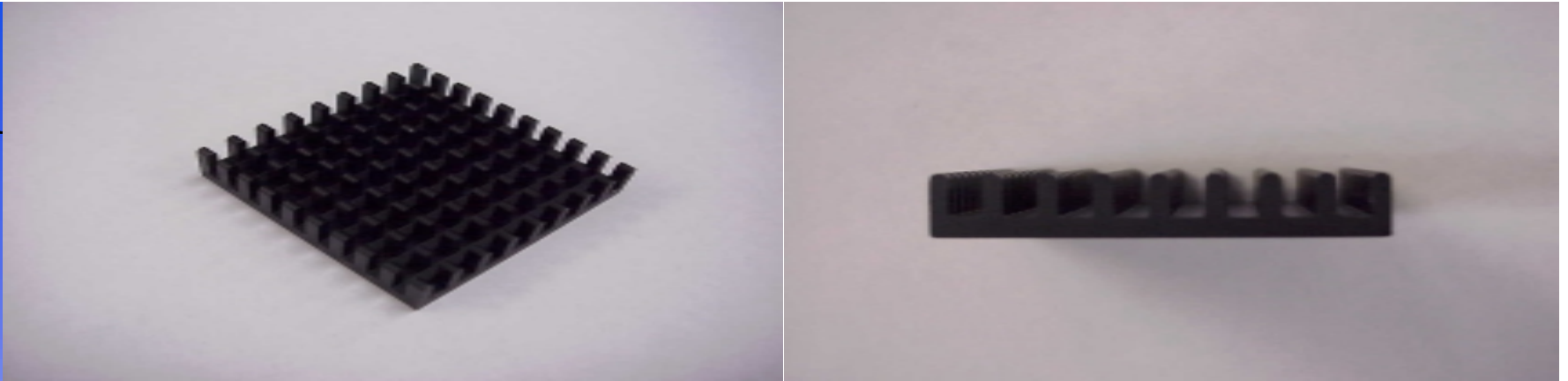




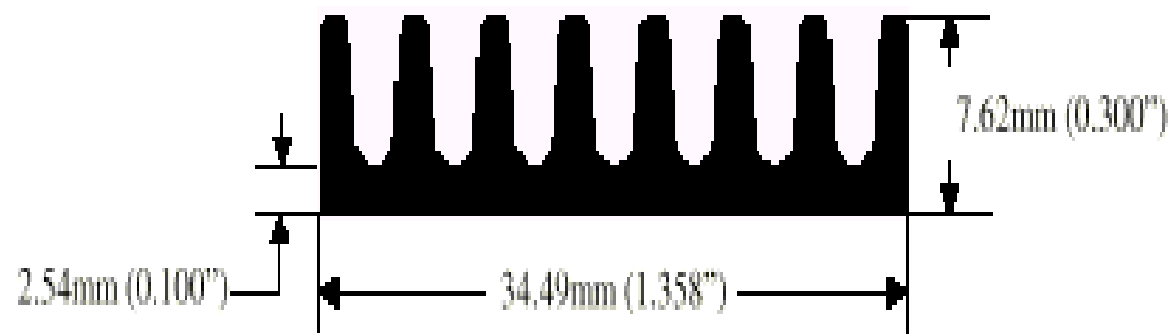
## 241BGA (23 x 23 mm) Heatsink Solution



Extruded Heatsink Drawing for the 820 MTH and 840 MRH-S



## 544 BGA (35 mm) Heatsink Solution



## Extruded Heatsink Drawing for the 840 MCH

# RDRAM Solutions

- Web sites listed below provide potential RDRAM Solution providers.
  - Customers need to validate their own suppliers and solutions.
- Web sites provide on-going status of RDRAM Solutions.

## **RDRAM Validation information**

- <http://developer.intel.com/design/chipsets/memory/rdr am/valid>
- <http://rambus.com/developer/validation.html>

## **RAMBUS Documentation - Data sheets, Design Specs, an Design Guides**

- [http://www.rambus.com/developer/development\\_support.html](http://www.rambus.com/developer/development_support.html)

# Vendor Lists and Contacts

Vendor Solutions	Part Number	Phone Number	Web Site
<b>Heatsink Solutions</b>			
<i>Heatsinks</i>			
Thermalloy	820 MIH- 22368B	1-972-243-4321	<a href="http://www.thermalloy.com">http://www.thermalloy.com</a>
	840 MCH- 21946B	"	"
	840 MRHS - 22368B	"	"
AAVID	820 MIH- 619953B00945	1-603-224-1117	<a href="http://www.AAVID.com">http://www.AAVID.com</a>
	840 MCH- 634553B01358	"	"
	840 MRHS - 619953B00945	"	"

# Vendor Lists and Contacts

Vendor Solutions	Part Number	Phone Number	Web Site
<b>Heatsink Solutions</b>			
<i>Heatsink Tape</i>			
Chomerics	T-410 23mm Package = P/N - WP075 35mm Package = P/N - WP110		<a href="http://www.chomerics.com/">http://www.chomerics.com/</a>
<i>Epoxy thermal Solution</i>			
Loctite	P/N = 383 or 384		<a href="http://www.loctite.com">http://www.loctite.com</a>
<b>RIMM/CRIMM Insertion Tool</b>	749217-001	(503) 648-7000	Unknown